**Topic**: Water level in the tank

**Question**: The water level in an inverted, cone-shaped funnel is decreasing at a rate of $0.5$ m/s. How fast is the water volume decreasing when the top of the water is at the point where the radius of the cone is $r = 2$?

**Answer choices**:

A $-\frac{3}{2}\pi$ m$^3$/s

B $-\frac{4}{3}\pi$ m$^3$/s

C $-\frac{2}{3}\pi$ m$^3$/s

D $-\frac{1}{3}\pi$ m$^3$/s

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**Solution**: C

As with any related rates problem, the first thing we should do is write down what we know.

Change in water height with respect to time

$$\frac{dh}{dt} = -\frac{1}{2}$$

Radius of the funnel at the point of interest

$$r = 2$$

Volume of the water in the cone-shaped funnel

$$V = \frac{1}{3}\pi r^2 h$$

And then we write down what we need to find.

Change in water volume with respect to time

$$\frac{dV}{dt}$$

Since we know we need to solve for $dV/dt$, we can expect to use implicit differentiation to take the derivative of the equation for volume of the water, since taking the derivative of that equation with respect to time will give us $dV/dt$ on the left.

So, starting with our water volume equation, we'll first plug in any values we already have, in this case $r = 2$.

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$$V = \frac{1}{3}\pi r^2 h$$

$$V = \frac{1}{3}\pi (2)^2 h$$

$$V = \frac{4}{3}\pi h$$

Now we'll use implicit differentiation to take the derivative of both sides of the equation with respect to time.

$$(1)\frac{dV}{dt} = \frac{4}{3}\pi (1)\frac{dh}{dt}$$

Plugging in $dh/dt = -1/2$, we get

$$\frac{dV}{dt} = \frac{4}{3}\pi \left(-\frac{1}{2}\right)$$

$$\frac{dV}{dt} = -\frac{2}{3}\pi$$

The fact that $dV/dt$ is negative tells us that the water volume is decreasing, and we can say that the water volume is decreasing at a rate of $-(2/3)\pi$ $m^3/s$.

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**Topic**: Water level in the tank

**Question**: Water is being pumped from a cylindrical tank with a radius of $3$ ft at a rate of $18$ cubic feet per minute. How fast is the water level falling when the water is $2$ ft deep?

**Answer choices**:

A $-\frac{2}{\pi}$ ft/min

B $-2$ ft/min

C $-\pi$ ft/min

D $-\frac{\pi}{2}$ ft/min

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**Solution**: A

As with any related rates problem, the first thing we should do is write down what we know.

Change in water volume with respect to time $\frac{dV}{dt} = -18$

Base radius of the tank $r = 3$

Volume of the water in the cylindrical tank $V = \pi r^2 h$

And then we write down what we need to find.

Change in water volume with respect to time $\frac{dh}{dt}$

Since we know we need to solve for $dh/dt$, we can expect to use implicit differentiation to take the derivative of the equation for volume of the water, since taking the derivative of that equation with respect to time will give us $dh/dt$ on the right.

So, starting with our water volume equation, we'll first plug in any values we already have, in this case $r = 3$.

$$V = \pi r^2 h$$

$$V = \pi(3)^2 h$$

$$V = 9\pi h$$

Now we'll use implicit differentiation to take the derivative of both sides of the equation with respect to time.

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$$(1)\frac{dV}{dt} = 9\pi(1)\frac{dh}{dt}$$

Plugging in $dV/dt = -18$, we get

$$-18 = 9\pi\frac{dh}{dt}$$

$$-\frac{18}{9\pi} = \frac{dh}{dt}$$

$$\frac{dh}{dt} = -\frac{2}{\pi}$$

The fact that $dh/dt$ is negative tells us that the water height is decreasing, and we can say that the water volume is decreasing at a rate of $-2/\pi$ ft/min.

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**Topic**: Water level in the tank

**Question**: Water is being pumped from a cylindrical tank with a radius of $2$ ft at a rate of $10$ cubic feet per minute. How fast is the water level falling when the water is $5$ ft deep?

**Answer choices**:

A $-\frac{2\pi}{5}$ ft/min

B $-\frac{5}{2\pi}$ ft/min

C $-\frac{3}{2\pi}$ ft/min

D $-\frac{2\pi}{3}$ ft/min

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**Solution**: B

As with any related rates problem, the first thing we should do is write down what we know.

Change in water volume with respect to time $\frac{dV}{dt} = -10$

Base radius of the tank $r = 2$

Volume of the water in the cylindrical tank $V = \pi r^2 h$

And then we write down what we need to find.

Change in water volume with respect to time $\frac{dh}{dt}$

Since we know we need to solve for $dh/dt$, we can expect to use implicit differentiation to take the derivative of the equation for volume of the water, since taking the derivative of that equation with respect to time will give us $dh/dt$ on the right.

So, starting with our water volume equation, we'll first plug in any values we already have, in this case $r = 2$.

$$V = \pi r^2 h$$

$$V = \pi(2)^2 h$$

$$V = 4\pi h$$

Now we'll use implicit differentiation to take the derivative of both sides of the equation with respect to time.

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$$(1)\frac{dV}{dt} = 4\pi(1)\frac{dh}{dt}$$

Plugging in $dV/dt = -10$, we get

$$-10 = 4\pi\frac{dh}{dt}$$

$$-\frac{10}{4\pi} = \frac{dh}{dt}$$

$$\frac{dh}{dt} = -\frac{5}{2\pi}$$

The fact that $dh/dt$ is negative tells us that the water height is decreasing, and we can say that the water level is decreasing at a rate of $-5/2\pi$ ft/min.

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